

Differences In Bird Foraging Behaviour Between Sonoran Desert And Urban Habitats:

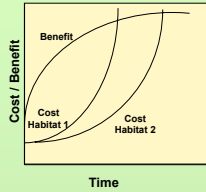
A Field Experiment With Seed Trays

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A theory of optimal foraging¹ predicts that foragers should quit food patches when the total cost of foraging equals the benefit. Therefore, forager's quitting harvest rate in a lower cost habitat should exceed that in a higher cost habitat.

$$H = C + P + MOC$$

H - harvest
C - physiological cost
P - cost of predation
MOC - missed opportunity cost



We ask whether foraging costs differ between Sonoran desert and urban habitats in central Arizona. Earlier studies on bird communities in the southwest²⁻⁵ suggested that the much higher bird densities observed in urban habitats compared with desert are due to higher resource densities (water and food) in the urban habitat.

If so, foragers in the urban habitat should quit food patches earlier than desert foragers. This can be tested experimentally using artificial food patches and measuring the amount of food leftovers (the Giving Up Density - GUD)⁶.

Predictions:

- 1) In the urban habitat birds will quit food patches earlier than desert foragers, since the MOC (in terms of supplementary bird feeders and seed production by exotic plants) is higher (i.e. lower GUDs in desert).
- 2) In the dry season GUDs will be lower when water containers are added to the trays in the desert (water decreases C for dry seeds). There will be no water effect in the urban habitat where water is readily available.

Methods

- Since October 2000 seed trays containing 3 liter of sand and 20 grams of millet seeds were placed in residential backyards and desert parks around Tempe Arizona.
- Each tray was placed in the field for 24 h. During the experiment the minimum and maximum ambient temperature were measured. In the city trays were placed on stools, and in the desert on top of Cholla cactus, to prevent the access of rodents.
- The trays were observed for 2-3 hours after being placed in the field, and again before they were collected, and all foraging species were recorded.
- For most analyses we selected data from seed trays where only House Finches (*Carpodacus mexicanus*) foraged, since this small granivore is abundant in both desert and urban habitats.
- In the lab we sifted the sand and cleaned all material other than millet seed. The leftover seed amount was measured to the nearest 1 g.



Experiment 1

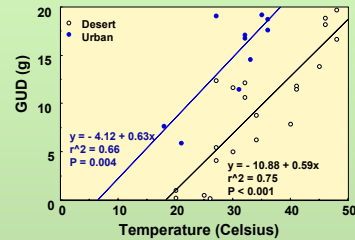
Are desert GUDs lower than urban GUDs?

- We measured GUDs on trays where House Finches were foraging solely, in desert and urban habitats. Temperature served as a covariate.

Results:

- Desert GUDs were lower than urban GUDs.
- Both habitat and temperature independently affected GUDs, but there was no interaction.

Source	DF	SS	F	P
Habitat	1	403.7	42.5	< 0.0001
Temperature	1	718.1	75.7	< 0.0001
Temp * Habitat	1	0.42	0.04	0.8371



Experiment 3

Are the higher House Finch GUDs in urban habitats a result of coexistence with House Sparrows?

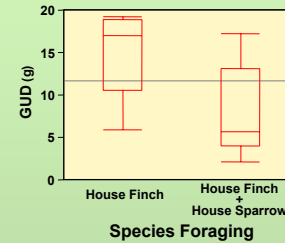
- In the urban habitat we compared GUDs on trays where foragers were (1) House Finch solely, and (2) House Sparrow and House Finch

Results:

- GUDs were significantly lower in the presence of House Sparrows.

Habitat	N	Score Sum	Score Mean	(Mean - Mean0)	Std0
Desert	10	124	12.4	2.532	
Urban	8	47	5.8	-2.532	

Kruskal-Wallis Test $\chi^2 = 6.63$ P = 0.01



Conclusions

Resource density (MOC):

- Results from experiments 1-2 do not support our first hypothesis. Although it is likely that the urban habitat is much richer in food density, the missed opportunity cost may be similar to that in the desert since bird densities in the urban habitat are much higher than in the desert (the 'resource matching' rule).
- Results from experiment 1 therefore suggest that the House Finch is an outlier species, since its GUDs are lower in the desert.
- Results from experiment 3 suggest that House Finch, perhaps the only small granivore sympatric with House Sparrow, behaves differently in the desert and urban habitats. Coexistence might be facilitated by spatial variation in resource abundance, due to a trade-off between foraging efficiency and travel cost⁷. House Finches cover much longer distances while moving between foraging patches. House Sparrows are more localized foragers and spend more time in a given food patch. Therefore they are more efficient in exploiting food.

Water Availability (C):

- Preliminary results from experiment 4 indicate the importance of water for population establishment and growth in urban environments. Exotic species in the south west (House Sparrow, Rock Dove, European Starling and Inca Dove) are all abundant city dwelling species⁸.

Behavioural responses to the change in resource availability due to urbanisation may in turn determine population density and community structure.

Experiment 2

Is it due to lower missed opportunity costs in the desert?

- If so, other species should show the same pattern as the House Finch.
- We measured GUDs on multi-species trays in desert and urban habitats

Species observed:

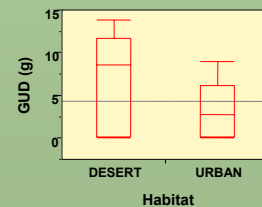
Urban foragers	Desert foragers
Inca Dove	Curve-billed Thrasher
Mourning Dove	Cactus Wren
Curve-billed Thrasher	Black-throated Sparrow
Abert's Towhee	Northern Cardinal
House Sparrow	House Finch

Results:

- There was no significant difference in GUDs between habitats. On average urban GUDs were even lower than Desert GUDs.

Habitat	N	Score Sum	Score Mean	(Mean - Mean0)	Std0
Desert	13	267	20.57	1.127	
Urban	22	362	16.47	-1.127	

Kruskal-Wallis Test $\chi^2 = 1.127$ P = 0.25



Experiment 4

In the dry season, does water availability in the city decrease physiological costs for foraging?

- If so, water supplement in the desert should decrease GUD.
- We measured GUDs on multi-species trays in the desert with and without water bowls.

Results (preliminary):

- In the desert, supplemental water decreased GUDs significantly.
- In the Urban habitat water did not affect GUD.

Repeated Measures ANOVA				
Source	DF	SS	F ratio	P-value
Water	1	42.4	5.34	0.0412
Tray	11	485.6	5.56	0.0042

References

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3. Emlen J. T. 1974. An urban bird community in Tucson, Arizona: derivation, structure, regulation. Condor 76:184-197.
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